OURCES REPORT NUMBER FORTY-ONE
ARIZONA STATE LAND DEPARTMENT
OBED M. LASSEN, COMMISSIONER

GROUND-WATER CONDITIONS IN THE RANEGRAS PLAIN, YUMA COUNTY, ARIZONA

BY P. C. BRIGGS

EPARED BY THE GEOLOGICAL SURVEY
ITED STATES DEPARTMENT OF THE INTERIOR

PHOENIX, ARIZONA
SEPTEMBER 1969

ARIZONA STATE LAND DEPARTMENT WATER-RESOURCES REPORTS

The following reports are available for distribution at the Arizona State Land Department, 422 State Office Building, Phoenix, and at U. S. Geological Survey offices in: 2555 East First Street, Tucson; and 5017 Federal Building, 230 North First Avenue, Phoenix. Those marked with an asterisk (*) are out of print and are available on loan only from the U.S. Geological Survey, 2555 East First Street, Tucson.

No.

* 1. Pumpage and ground-water levels in Arizona in 1955, by P. W. Johnson, N. D. White, and J. M. Cahill: 69 p., 30 figs., 1956.

* 2. Annual report on ground water in Arizona, spring 1956 to spring 1957, by J. W. Harshbarger and others: 42 p., 18 figs., 1957.

* 3. Geology and ground-water resources of the Harquahala Plains area, Maricopa and Yuma Counties, Arizona, by D. G. Metzger: 40 p., 2 pls., 7 figs., 1957.

* 4. Geology and ground-water resources of the Palomas Plain-Dendora Valley area, Maricopa and Yuma Counties, Arizona, by C. A. Armstrong and C. B. Yost, Jr.: 49 p., 3 pls., 4 figs., 1958.

* 5. Annual report on ground water in Arizona, spring 1957 to spring 1958, by W. F. Hardt, J. M. Cahill, and M. B. Booher: 60 p., 19 figs., 1958.

* 6. Annual report on ground water in Arizona, spring 1958 to spring 1959, by W. F. Hardt, R. S. Stulik, and M. B. Booher: 61 p., 18 figs., 1959.

* 7. Annual report on ground water in Arizona, spring 1959 to spring 1960, by W. F. Hardt, R. S. Stulik, and M. B. Booher: 89 p., 22 figs., 1960.

* 8. Geology and ground-water resources of the McMullen Valley, Maricopa, Yavapai, and Yuma Counties, Arizona, by William Kam: 72 p., 17 figs., 1961.

9. Hydrologic data and drillers' logs, Papago Indian Reservation, Arizona, by L. A. Heindl and O. J. Cosner, with a section on chemical quality of the water by L. R. Kister: 116 p., 3 figs., 1961.

*10. Annual report on ground water in Arizona, spring 1960 to spring 1961, by N. D. White, R. S. Stulik, E. K. Morse, and others: 93 p., 32 figs., 1961.

*11. Annual report on ground water in Arizona, spring 1961 to spring 1962, by N. D. White, R. S. Stulik, and others: 116 p., 35 figs., 1962.

No.

*12A. Geohydrologic data in the Navajo and Hopi Indian Reservations, Arizona, New Mexico, and Utah—Part I, Records of ground-water supplies, by G. E. Davis, W. F. Hardt, L. K. Thompson, and M. E. Cooley: 159 p., 3 figs., 1963.

*12B. Geohydrologic data in the Navajo and Hopi Indian Reservations, Arizona, New Mexico, and Utah—Part II, Selected chemical analyses of the ground water, by L. R. Kister and J. L. Hatchett: 58 p., 2 figs., 1963.

12C. Geohydrologic data in the Navajo and Hopi Indian Reservations, Arizona, New Mexico, and Utah—Part III, Selected lithologic logs, drillers' logs, and stratigraphic sections, by M. E. Cooley, J. P. Akers, and P. R. Stevens: 157 p., 3 figs., 1964.

12D. Geohydrologic data in the Navajo and Hopi Indian Reservations, Arizona, New Mexico, and Utah—Part IV, Maps showing locations of wells, springs, and stratigraphic sections, by M. E. Cooley and others: 2 sheets, 1966.

12E. Geohydrologic data in the Navajo and Hopi Indian Reservations, Arizona, New Mexico, and Utah—Part I-A, Supplemental records of ground-water supplies, by E. H. McGavock, R. J. Edmonds, E. L. Gillespie, and P. C. Halpenny: 55 p., 4 figs., 1966.

13. Desert floods—a report on southern Arizona floods of September 1962, by D. D. Lewis: 13 p., 18 figs., 1963.

*14. Basic ground-water data of the Willcox basin, Graham and Cochise Counties, Arizona, by S. G. Brown, H. H. Schumann, L. R. Kister, and P. W. Johnson: 93 p., 15 figs., 1963.

*15. Annual report on ground water in Arizona, spring 1962 to spring 1963, by N. D. White, R. S. Stulik, E. K. Morse, and others: 136 p., 47 figs., 1963.

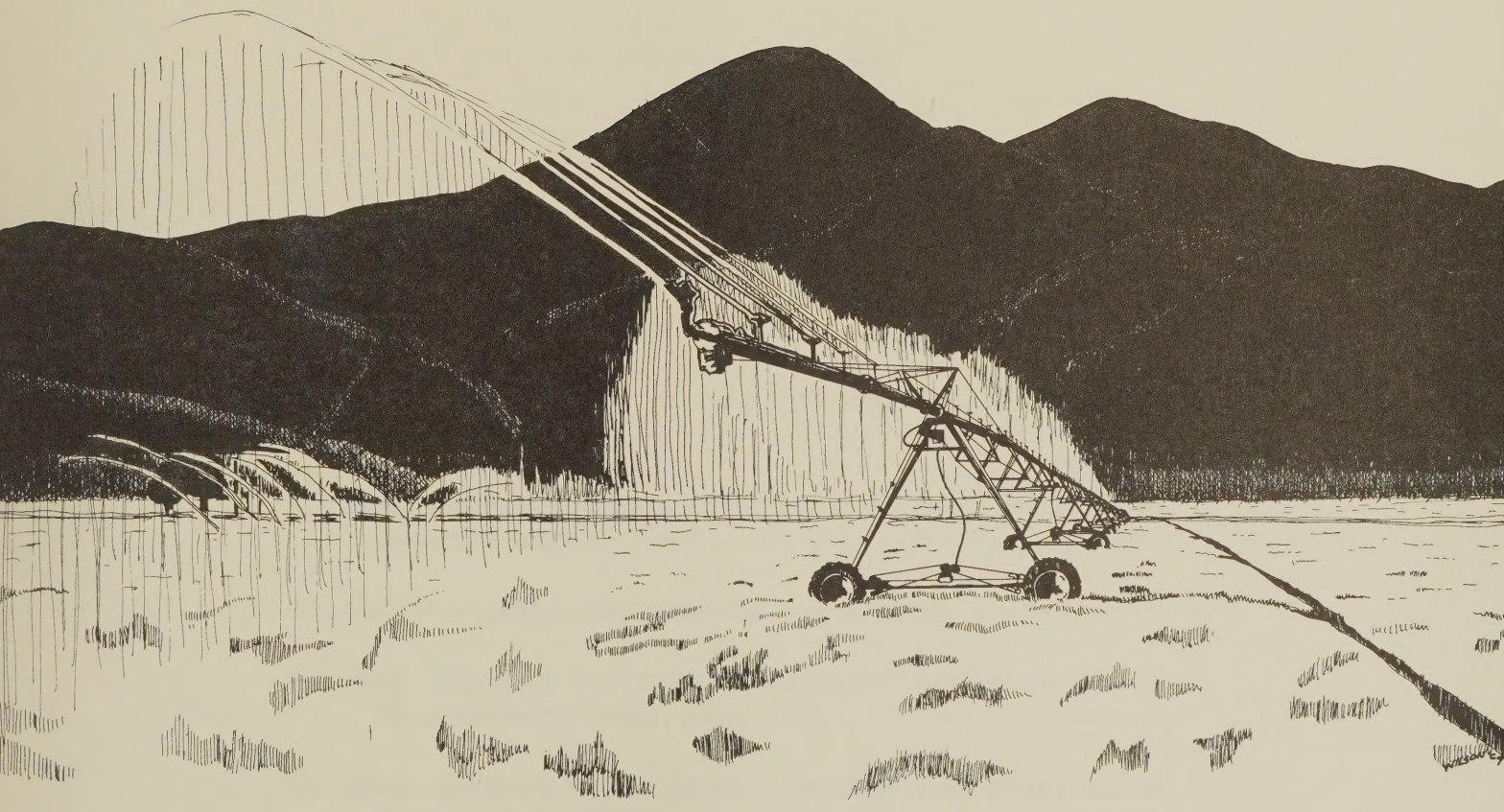
16. Effects of ground-water withdrawal in part of central Arizona projected to 1969, by N. D. White, R. S. Stulik, and C. L. Rauh: 25 p., 7 figs., 1964.

(Continued on inside back cover)

WATER-RESOURCES REPORT NUMBER FORTY-ONE
ARIZONA STATE LAND DEPARTMENT
OBED M. LASSEN, COMMISSIONER

GROUND-WATER CONDITIONS IN THE RANEGRAS PLAIN, YUMA COUNTY, ARIZONA

BY P. C. BRIGGS



PREPARED BY THE GEOLOGICAL SURVEY
UNITED STATES DEPARTMENT OF THE INTERIOR

PHOENIX, ARIZONA
SEPTEMBER 1969

CONTENTS

ILLUSTRATIONS

TABLES

GROUND-WATER CONDITIONS IN THE RANEGRAS PLAIN, YUMA COUNTY, ARIZONA

By

P. C. Briggs

Introduction

The ground-water reservoir is the only dependable source of water in the Ranegras Plain (fig. 1), and it is important that the supply be managed properly. Therefore, a comprehensive knowledge of the factors that control the quantity and quality of the water stored in the ground-water reservoir is necessary. This report describes the ground-water conditions and water-level trends in the Ranegras Plain and makes available hydrologic data that are useful in planning and studying water-resources development.

As a part of the continuing ground-water program in Arizona, the U. S. Geological Survey, in cooperation with the Arizona State Land Department, O. M. Lassen, Commissioner, collects, compiles, and analyzes data on the occurrence and development of ground water in the State. The data presented in this report were collected as a part of the continuing program. The study was conducted under the immediate supervision of H. M. Babcock, district chief of the Water Resources Division of the U. S. Geological Survey in Arizona.

The Ranegras Plain is about 100 miles west of Phoenix in western Arizona (fig. 1). The plain is in the Basin and Range lowlands province and is about 50 miles long and 15 miles wide. It is bordered on the north by the Bouse Hills, on the east by the Granite Wash Mountains, and on the west by the Plomosa Mountains. The valley floor slopes gently northwestward and is drained by Bouse Wash, an ephemeral tributary of the Colorado River. The wash leaves the plain at the northwest end of the area near Bouse.

The climate is arid; the average precipitation from 1952 to 1967 was 4.98 inches at Bouse (U. S. Weather Bureau, issued annually). Precipitation is inadequate for raising crops, and there is no usable surface-water supply; therefore, it is necessary to pump ground water for irrigation. Nearly all the cultivated acreage and ground water pumped are within

Alluvial contacts by M. E. Cooley, 1967

EXPLANATION

ALLUVIAL DEPOSITS

CONSOLIDATED ROCKS

FIGURE 1.--AREA OF REPORT AND ARIZONA'S WATER PROVINCES.

an area of about 200 square miles north of U. S. Highway 60-70 and south of Bouse. The first large irrigation wells were drilled in the plain in 1948. By spring 1949, about 1,000 acres of land was irrigated; by 1957 the amount being irrigated had increased to 5,200 acres, but by 1967 only 2,800 acres was being irrigated.

The cultivated acreage was mapped for this study using aerial photographs taken in 1967; an inventory of irrigation wells in the Ranegras Plain also was made in 1967 (fig. 2). Data for the wells—including date drilled, casing information, water levels, pumping data, and other information—are given in table 1 (see appendix). Other data in the appendix include drillers' logs of selected wells (table 2), field determinations of temperature and specific conductance of water from selected wells (table 3), and chemical analyses of water from selected wells (table 4). The well locations are shown on figure 2; all well locations are described according to the well-numbering system used in Arizona (fig. 3).

The water resources and geology of the Ranegras Plain have been discussed briefly in several reports. These reports, and a more comprehensive report on the geology and ground-water resources of the northern part of the plain (Metzger, 1951), are given in the selected references.

Ground Water

The major ground-water reservoir in the Ranegras Plain is the alluvium that fills the trough between the mountain ranges. The total thickness of the alluvium is not known, but a few wells drilled more than 1,200 feet deep bottomed in alluvium. Drillers' logs of wells (table 2) show that the alluvium is composed of sand, gravel, and clay, and the logs of some wells show a predominance of clay and only small amounts of sand and gravel. The available data indicate low specific capacities of wells—from about 3 to 10 gpm (gallons per minute) per foot of drawdown. In 1967 the depth to water in the plain ranged from less than 40 feet below the land surface near Bouse in the northern part of the area to nearly 400 feet near Vicksburg in the east-central part of the area (fig. 2).

Prior to 1948, there had been no large withdrawals from the ground-water reservoir in the Ranegras Plain. Contours of the altitude of the water level in 1948 (fig. 4) indicate that ground water moved generally northwestward toward Bouse, where it was discharged from the valley. Some ground water moved southwest into the Ranegras Plain from Butler Valley.

The gradient of the ground-water surface near Bouse was about 20 feet per mile in 1948. A ground-water barrier, probably formed by outcrops of the Plomosa Mountains and the Bouse Hills, is indicated by the sharp drop in water level northwest of Bouse (figs. 2 and 4). A similar barrier probably was present between the Bouse Hills and the Granite Wash Mountains, where ground water moved into the Ranegras Plain from Butler Valley. The contours for 1948 (fig. 4) also indicate possible recharge from the Plomosa Mountains near the Bear Hills.

From 1948 through 1967, about 211,000 acre-feet of ground water was pumped in the Ranegras Plain. The water-level contours for 1967 (fig. 5) show some effects of the pumping. Ground water continued to move northwestward toward Bouse, where it leaves the valley; however, the gradient of the ground-water surface at the outlet near Bouse had decreased to less than 15 feet per mile, which indicates a decrease in the outflow from the valley. Near the upper end of the plain, the gradient steepened slightly between 1948 and 1967, and the contours for 1967 show that a cone of depression is beginning to form as a result of the withdrawal of ground water.

Changes in water level in the Ranegras Plain have been minor to the present time (1967). Figure 6 shows that water levels have declined more than 15 feet in only a small part of the area and that declines in water level of from 10 to 15 feet have occurred in a fairly large area. The areas of water-level decline do not coincide exactly with the cultivated areas shown on figure 2. However, nearly half the land irrigated in 1957 and earlier had been abandoned by 1967, and it is probable that the patterns of decline reflect this condition. From 1948 through 1967, about 600,000 acre-feet of sediment was dewatered by pumping of ground water in the Ranegras Plain. If it is assumed that the specific yield of the sediments is from 0.15 to 0.20, then from 90,000 to 120,000 acre-feet of ground water was removed from storage in the period 1948-67, and the remainder (from 91,000 to 121,000 acre-feet) of the 211,000 acre-feet of ground water pumped was supplied by recharge. Therefore, during the 20-year period, about half of the ground water pumped was withdrawn from storage, and half was supplied by recharge. Metzger (1951) estimated that the average annual recharge to the ground-water reservoir in the Ranegras Plain was from 5,000 to 15,000 acre-feet.

Figure 7 shows water levels in selected wells and pumpage of ground water from 1950 through 1967. The withdrawal of ground water has resulted in a general decline in water levels, although in a few places some slight recovery has taken place since 1964, when the amount of ground water pumped decreased from that of the preceding few years.

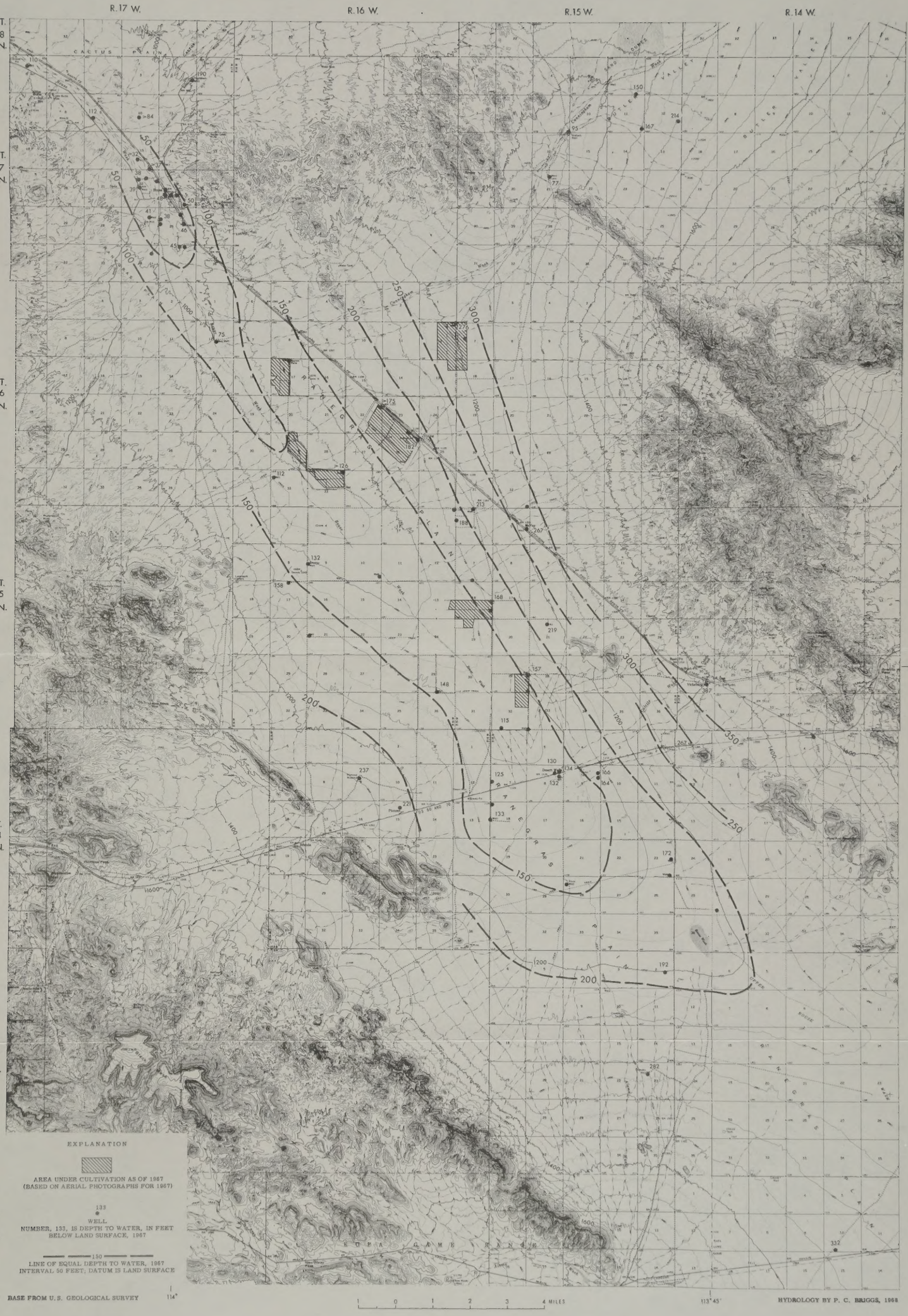
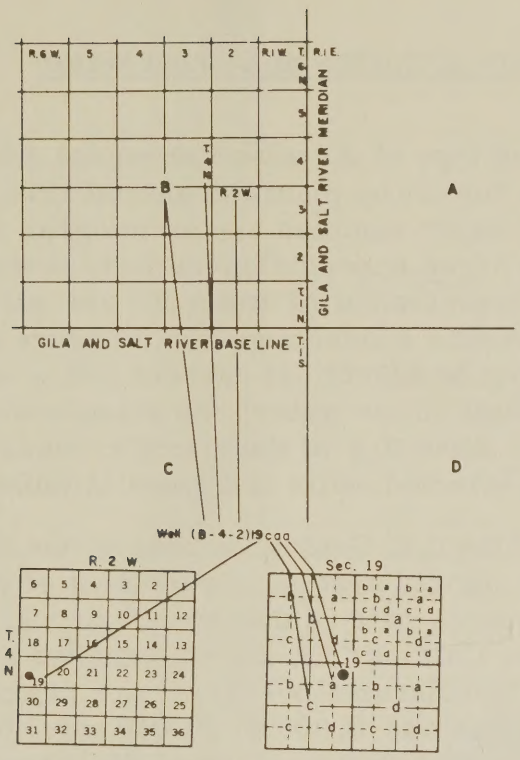


FIGURE 2.--LOCATION OF WELLS, CULTIVATED AREAS, AND DEPTH TO WATER, 1967, IN THE RANEGRAS PLAIN.



The well numbers used by the Geological Survey in Arizona are in accordance with the Bureau of Land Management's system of land subdivision. The land survey in Arizona is based on the Gila and Salt River meridian and base line, which divide the State into four quadrants. These quadrants are designated counterclockwise by the capital letters A B, C, and D. All land north and east of the point of origin is in A quadrant, that north and west in B quadrant, that south and west in C quadrant, and that south and east in D quadrant. The first digit of a well number indicates the township, the second the range, and the third the section in which the well is situated. The lowercase letters a, b, c, and d after the section number indicate the well location within the section. The first letter denotes a particular 160-acre tract, the second the 40-acre tract, and the third the 10-acre tract. These letters also are assigned in a counterclockwise direction, beginning in the northeast quarter. If the location is known within the 10-acre tract, three lowercase letters are shown in the well number. In the example shown, well number (B-4-2)19caa designates the well as being in the $NE\frac{1}{4}NE\frac{1}{4}SW\frac{1}{4}$ sec. 19, T. 4 N., R. 2 W. Where there is more than one well within a 10-acre tract, consecutive numbers beginning with 1 are added as suffixes.

FIGURE 3.--WELL-NUMBERING SYSTEM IN ARIZONA.

Chemical Quality of Ground Water

The amount and type of dissolved chemical constituents in water determine its suitability for use by plant and animal life; therefore, the collection and analysis of water samples are an integral part of any water-resources study. Table 3 (see appendix) gives field determinations of temperature and specific conductance of water from selected wells in the Ranegras Plain. The specific conductance is a measure of the ability of the ions in solution to conduct an electrical current and is an indication of the amount of dissolved solids in the water; the dissolved-solids content, in milligrams per liter, is about 0.6 of the specific conductance. Chemical analyses of water from selected wells are given in table 4 (see appendix).

The Director of the U.S. Geological Survey has approved the change from the English to the metric system in reporting of water-quality data. Therefore, the water-quality data in this report are given in milligrams per liter (mg/l), degrees Celsius (°C), and micromhos at 25°C. The terms "parts per million" and "milligrams per liter" are practically synonymous for water containing as much as 5,000 to 10,000 mg/l of dissolved solids. The exact amount is dependent on the nature of the dissolved material. The Survey has set 7,000 mg/l dissolved solids as the point above which the difference in parts per million and milligrams per liter becomes significant. In order to convert data from one system to the other, a density factor must be applied to the analytical results of all water containing more than 7,000 mg/l of dissolved solids.

Temperature data given in tables 3 and 4 (see appendix) can be converted to degrees Fahrenheit (°F) by using the following:

°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C
32	0	48	9	64	18	80	27	96	36	112	44
33	1	49	9	65	18	81	27	97	36	113	45
34	1	50	10	66	19	82	28	98	37	114	46
35	2	51	11	67	19	83	28	99	37	115	46
36	2	52	11	68	20	84	29	100	38	116	47
37	3	53	12	69	21	85	29	101	38	117	47
38	3	54	12	70	21	86	30	102	39	118	48
39	4	55	13	71	22	87	31	103	39	119	48
40	4	56	13	72	22	88	31	104	40	120	49
41	5	57	14	73	23	89	32	105	41	121	49
42	6	58	14	74	23	90	32	106	41	122	50
43	6	59	15	75	24	91	33	107	42		
44	7	60	16	76	24	92	33	108	42		
45	7	61	16	77	25	93	34	109	43		
46	8	62	17	78	26	94	34	110	43		
47	8	63	17	79	26	95	35	111	44		

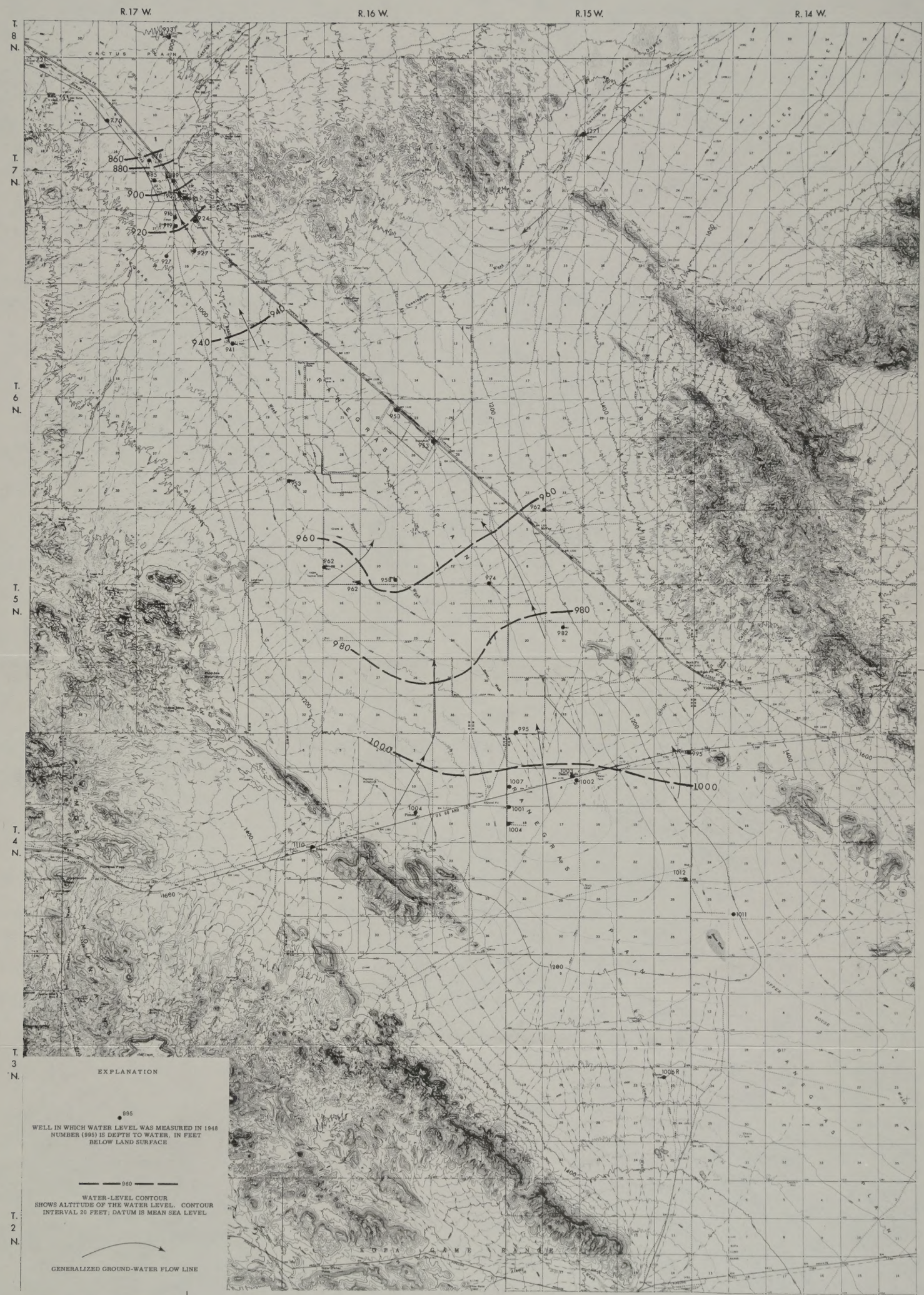


FIGURE 4.--WATER-LEVEL CONTOURS AND GENERALIZED FLOW PATTERN, 1948, IN THE RANEGRAS PLAIN.

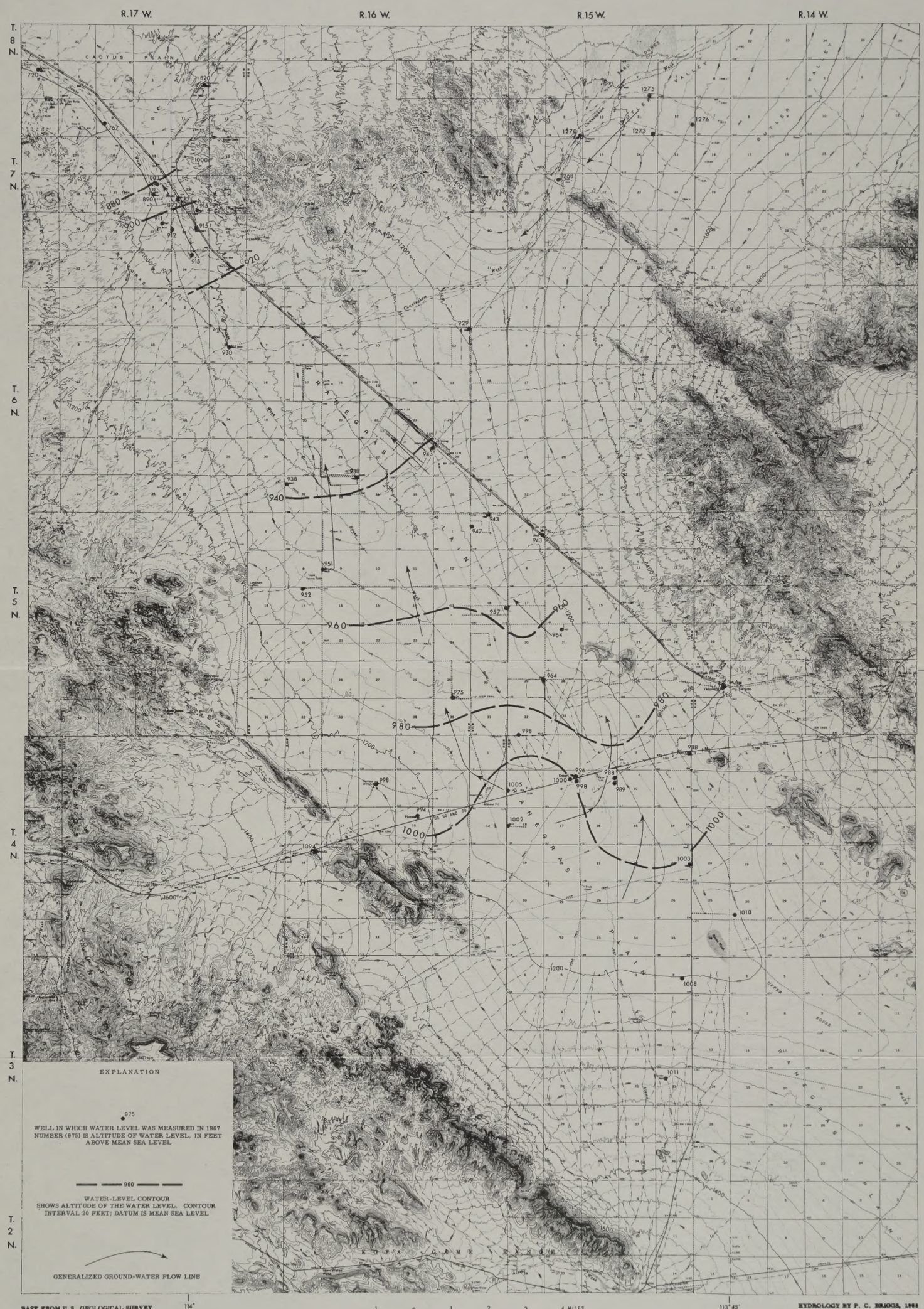


FIGURE 5.--WATER-LEVEL CONTOURS AND GENERALIZED FLOW PATTERN, 1967, IN THE RANEGRAS PLAIN.

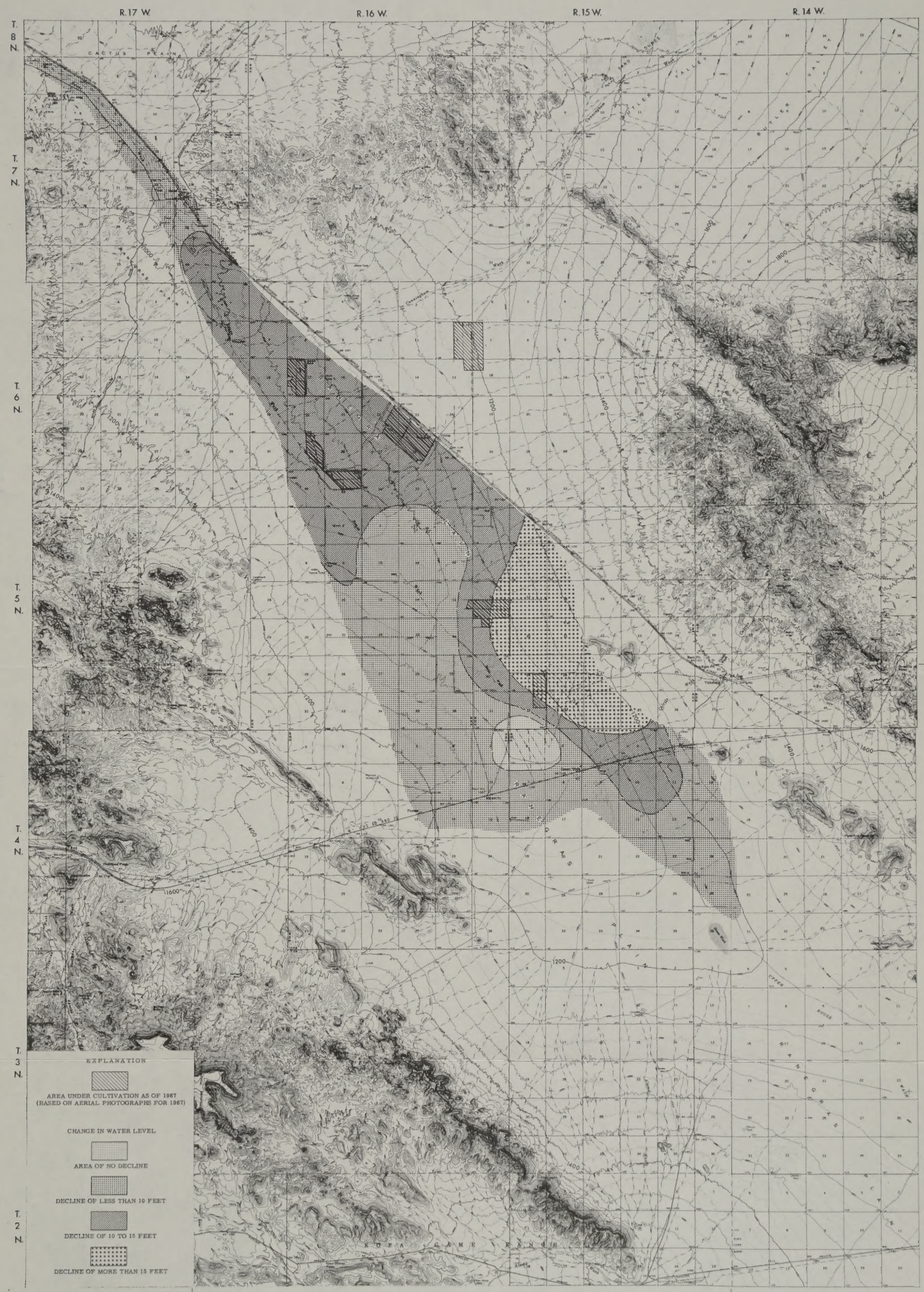


FIGURE 6.--CHANGE IN GROUND-WATER LEVELS FROM 1948 THROUGH 1967 IN THE RANEGRAS PLAIN.

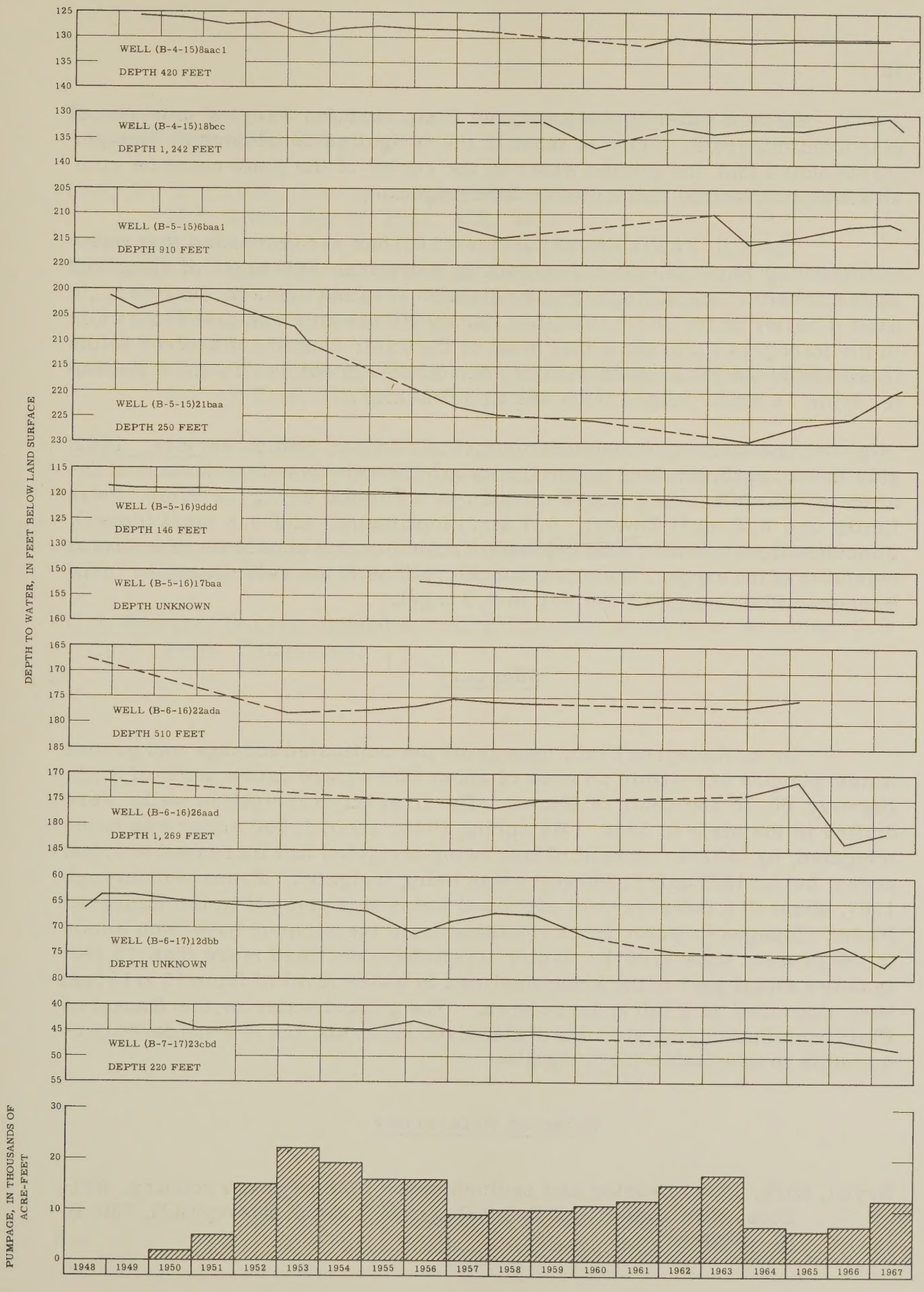


FIGURE 7.--WATER LEVELS IN SELECTED WELLS AND ANNUAL PUMPAGE IN THE RANEGRAS PLAIN.

Ground water in the Ranegras Plain contains varying amounts of dissolved minerals. Prior to most of the irrigation development, Metzger (1951) noted that the ground water in the center of the plain could be considered permissible to unsuitable for irrigation.

The U.S. Public Health Service (1962) has recommended that water for drinking purposes should contain no more than 500 mg/l of dissolved solids. Water containing a higher dissolved-solids content, however, is used if better water is not available. Analyses of water samples from wells in the Ranegras Plain show that most of the water contains dissolved solids in excess of the recommended limit; the dissolved-solids content of the water from 14 wells ranged from 462 to 3,700 mg/l.

The latest recommendations (U. S. Public Health Service, 1962) give lower, optimum, and upper limits for fluoride based on the annual average of maximum daily air temperature. For the Ranegras Plain, these limits are 0.6 mg/l (lower), 0.7 mg/l (optimum), and 0.8 mg/l (upper). Concentrations of more than twice the optimum value constitute grounds for rejection of the supply. Fluoride concentrations in the water sampled in the Ranegras Plain ranged from 4.1 to 8.9 mg/l.

Summary

In the Ranegras Plain, nearly all the cultivated acreage and ground water pumped are within an area of about 200 square miles north of U. S. Highway 60-70 and south of Bouse. The first large irrigation wells were drilled in the plain in 1948. By spring 1949, about 1,000 acres was being irrigated; by 1957 the amount of land being irrigated had increased to 5,200 acres, but by 1967 only 2,800 acres was being irrigated. From 1948 through 1967, about 211,000 acre-feet of ground water was pumped in the Ranegras Plain. Changes in water level resulting from the pumping have been minor to the present time (1967). Water levels have declined more than 15 feet in only a small part of the area; declines in water level of from 10 to 15 feet have occurred in a fairly large area. The ground water in the Ranegras Plain contains varying amounts of dissolved minerals and is considered permissible to unsuitable for irrigation.

Selected References

Bryan, Kirk, 1922, Erosion and sedimentation in the Papago country, Arizona, with a sketch of the geology: U.S. Geol. Survey Bull. 730-B, p. 19-90.

Darton, N. H., 1925, A resume of Arizona geology: Arizona Bur. Mines Bull. 119, 298 p.

Lee, W. T., 1908, Geologic reconnaissance of a part of western Arizona: U.S. Geol. Survey Bull. 352, 96 p.

Metzger, D.G., 1951, Geology and ground-water resources of the northern part of the Ranegras Plain area, Yuma County, Arizona: U.S. Geol. Survey open-file report, 31 p.

Ross, C. P., 1922, Geology of the lower Gila region, Arizona: U.S. Geol. Survey Prof. Paper 129-H, p. 183-197.

_____1923, The lower Gila region, Arizona, a geographic, geologic, and hydrologic reconnaissance, with a guide to desert watering places: U.S. Geol. Survey Water-Supply Paper 498, 237 p.

U.S. Public Health Service, 1962, Drinking water standards: U.S. Public Health Service Pub. 956, 61 p.

U.S. Weather Bureau, issued annually, Climatological data, Arizona: U.S. Dept. Commerce.

APPENDIX —— BASIC DATA

Table 1.--Records of selected wells in the Ranegras Plain

Well location: See page 7 for description of well-numbering system.
Perforated interval: OH, open hole.
Land-surface altitude: Determined from Geological Survey topographic maps.
Water level: R, reported.

Pumping data: R, reported.
Remarks: C, chemical analysis of water included in table 4; D, driller's log of well included in table 2; H, hydrograph of water level in well shown in figure 7; S, specific conductance of water included in table 3.

Well location	Date completed (year)	Reported depth (feet)	Diameter of casing (inches)	Depth of casing (feet)	Perforated interval (feet below land surface)	Land-surface altitude (feet above mean sea level)	Water level		Pumping data			Remarks
							Feet below land surface	Date (month, year)	Yield (gpm)	Pumping level (feet below land surface)	Date (month, year)	
(B-2-14)10cdc	1964	455	8	455	340- 380	1,350	332	4/68	100R	.....	6/65	D.
(B-3-15)2dab	.....	.....	20	.....	.....	1,200	192 188	8/67 4/68	.....	.....	.....	
23bdb	1947	318	6	.....	.....	1,293	287R 282	/47 8/67	.....	.....	.....	
(B-4-14)4aac	1959	652	6	652	577- 652	1,525	.....	.....	.....	.....	.....	
30cca	.....	250	8	.....	.....	1,197	186 187	11/48 8/67	.....	.....	.....	C.
(B-4-15)2daa	1944	300	8	.....	.....	1,255	260 267	11/48 4/68	.....	.....	.....	C.
7cbb	1948	528	20	480	135- 470 OH 480- 528	1,130	123 125	11/48 8/67	.....	.....	.....	D.
8aac1	1935	420	8	.....	.....	1,130	126 130 130	7/49 4/67 4/68	.....	.....	.....	C, H.
8aac2	.....	.....	6	.....	.....	1,130	127 134	11/48 8/67	.....	.....	.....	
8ada	1926	206	8	200	OH 200- 206	1,130	128 128 132	1/45 11/46 8/67	.....	.....	.....	
9aad	.....	.....	10	.....	.....	1,154	166	8/67	.....	.....	.....	
9ada	.....	.....	6	.....	.....	1,153	164	8/67	.....	.....	.....	
18bbb	1948	1,005	20	1,005	0-1,005	1,129	128	11/48	670	.....	3/49	D, C.
18bcc	1949	1,242	20	1,100	300-1,100 OH 1,100-1,242	1,135	131 133 132	5/49 8/67 4/68	800R	.....	1/66	D, H.
23daa	.....	.....	.....	.....	.....	1,175	172 179	8/67 4/68	.....	.....	.....	
23ddd	.....	.....	6	.....	.....	1,170	158	11/48	.....	.....	.....	
28bbd	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	C.
(B-4-16)9bda	.....	.....	8	.....	.....	1,235	237	8/67	.....	.....	.....	S.
15abc	1948	303	Uncased	.....	.....	1,215	211 221	11/48 8/67	.....	.....	.....	C.
19aba	.....	.....	6	.....	.....	1,353	243 259	11/48 8/67	.....	.....	.....	
(B-5-14)30ddb	.....	462	8	454	414- 454 OH 454- 462	1,375	387	4/68	.....	.....	.....	

Table 1.--Records of selected wells in the Ranegras Plain—Continued

Well location	Date completed (year)	Reported depth (feet)	Diameter of casing (inches)	Depth of casing (feet)	Perforated interval (feet below land surface)	Land-surface altitude (feet above mean sea level)	Water level		Pumping data			Remarks
							Feet below land surface	Date (month, year)	Yield (gpm)	Pumping level (feet below land surface)	Date (month, year)	
(B-5-15)5daa	1911	343	10	336	263- 316 OH 336- 343	1,210	253R 267	2/11 4/68	.....	.....	.....	D.
6baa1	1951	910	20	910	220- 910	1,156	212 213 213	1/57 6/67 4/68	1,950 1,510	 360	3/54 7/57	D, H, S.
6bcb	1952	960	20-16	910	248- 910 OH 910- 960	1,135	200R 188	4/52 6/67	1,260	.....	9/57	S.
7cdd	.....	163	8	.....	.....	1,120	146	11/48	.....	.....	.....	
18daa	.....	.....	.....	.....	.....	1,125	168	8/67	1,480	.....	7/57	S.
18dda	1952	1,000	20-16	1,000	600-1,000	1,121	150R	8/52	2,140 1,420	.....	3/54 7/57	D, S.
21baa	.....	250	6	.....	.....	1,183	201 220 219	11/48 4/67 8/67	.....	.....	.....	H, C.
29daa	1951	824	16	810	240- 810 OH 810- 824	1,121	143 157	10/51 8/67	1,000 870	397 446	7/57 6/67	D, S.
29ddd	1951	1,154	20-16	1,154	554-1,154	1,119	.....	.....	.....	.....	.....	D.
32ccd	1948	900	20	.....	.....	1,113	118 115	11/48 9/67	.....	.....	.....	
32ddd	1951	1,222	20-16	1,096	400-1,000 OH 1,096-1,222	1,115	.....	.....	530	.....	7/57	D, S.
(B-5-16)1aaa	1951	940	20-16	940	124- 940	1,136	197 178	3/54 6/67	.....	.....	.....	D; probably cascading water.
9bcc	.....	145	6	.....	.....	1,083	121 132	11/48 8/67	.....	.....	.....	C.
9ddd	.....	146	7	.....	.....	1,081	119 122 122	11/48 6/67 4/68	.....	.....	.....	H; perched water table.
10ddd	.....	164	16	.....	.....	1,071	113 113 114 115	2/46 11/48 6/67 4/68	.....	.....	.....	Perched water table.
17baa	.....	.....	18	.....	.....	1,110	152 158 158	3/56 6/67 4/68	.....	.....	.....	H.
21bcc	.....	132	6	.....	.....	1,135	Dry Dry	11/48 6/67	.....	.....	.....	
25dcc	1952	1,452	16-14	1,452	292-1,452	1,123	148	6/67	600	.....	7/52	D, S.
(B-6-15)7bcd	.....	800	.....	.....	.....	1,208	.....	.....	.....	.....	.....	

Table 1.--Records of selected wells in the Ranegras Plain—Continued

Well location	Date completed (year)	Reported depth (feet)	Diameter of casing (inches)	Depth of casing (feet)	Perforated interval (feet below land surface)	Land-surface altitude (feet above mean sea level)	Water level		Pumping data			Remarks
							Feet below land surface	Date (month, year)	Yield (gpm)	Pumping level (feet below land surface)	Date (month, year)	
(B-6-15)32ddd	.....	.....	8	.....	.....	1,230	268	2/49	.....	.....	.....	Formerly (B-6-15)32aac; location corrected in 1967.
(B-6-16)12aaa	.....	.....	20	.....	.....	1,205	276	8/67	1,810	390	5/67	S.
17baa	.....	550	20	550	.....	1,068	.....	.....	1,120 1,380 1,220	400 401	3/54 7/57 5/67	S.
22ada	1948	510	20	.....	.....	1,121	168 175	6/48 3/65	.....	288	6/67	D, H; originally drilled to 878 feet, now sand filled to 510-foot depth.
23ddc	1962	1,000	20	1,000	190-1,000	1,122	.....	.....	2,360	392	6/67	S.
26aad	1948	1,269	20-16	906	250- 906 OH 906-1,269	1,125	172 182	11/48 4/67	.....	.....	.....	D, C, H.
32bbc	.....	900	16	.....	.....	1,050	97 112	11/48 8/67	.....	.....	.....	
33aaa	1953	700	20-16	700	235- 700	1,064	123 126	3/54 2/63	3,100R 2,630	 242	6/54 5/67	D, S.
(B-6-17)12dbb	.....	.....	12	.....	.....	1,005	63 64 75 79	1/45 10/48 8/67 4/68	.....	.....	.....	H.
(B-7-15)2ddc	1964	552	20-16	500	480- 500 OH 500- 552	1,425	150	5/67	3,000R	268R	.....	
9ddd	1950	145	6	.....	.....	1,365	94 95	2/50 5/67	.....	.....	.....	
11ddd	1966	404	20	404	40- 404	1,440	167	5/67	.....	.....	.....	
12dad	1966	680	16	680	40- 680	1,490	214	5/67	.....	.....	.....	
21ba	1962	202	8	146	OH 146- 202	1,345	77	5/67	.....	.....	.....	
(B-7-17)2daa	.....	.....	6	.....	.....	1,010	190	8/67	.....	.....	.....	
6bad	1946	134	6	.....	.....	830	109 109 110	2/46 11/48 8/67	.....	.....	.....	C.
9cbd	.....	158	6	.....	0- 158	879	109 112	11/48 8/67	.....	.....	.....	
10ca	.....	.....	.....	.....	.....	940	84	11/48	.....	.....	.....	Unable to locate in 1967.
15cac	1905	48	6	.....	.....	910	32	11/48	.....	.....	.....	C.

Table 1.--Records of selected wells in the Ranegras Plain--Continued

Well location	Date completed (year)	Reported depth (feet)	Diameter of casing (inches)	Depth of casing (feet)	Perforated interval (feet below land surface)	Land-surface altitude (feet above mean sea level)	Water level		Pumping data			Remarks
							Feet below land surface	Date (month, year)	Yield (gpm)	Pumping level (feet below land surface)	Date (month, year)	
(B-7-17)15dcd	1949	125	8	.....	.....	920	37	3/49	.....	.....	.....	
22aad1	.....	44	48	.....	.....	930	41	11/48	.....	.....	.....	C.
22abc	.....	176	.....	.....	.....	921	28 38	1/45 4/67	.....	.....	.....	
22acc	1933	.....	14	.....	.....	929	39	8/67	.....	.....	.....	
22bad	.....	90	6	.....	.....	920	35	11/48	.....	.....	.....	
23ca	1911	690	13-8-6	690	490- 690	942	53	11/48	.....	.....	.....	D.
23cac	1946	92	6	68	OH 68- 92	945	35	11/48	.....	.....	.....	C.
23cba	1948	90	6	.....	.....	945	42	11/48	.....	.....	.....	
23cbd	1949	220	6	.....	.....	941	43 48 48	8/50 4/67 8/67	.....	.....	.....	H.
23dcd	.....	.....	.....	.....	.....	965	50	8/67	.....	.....	.....	
26abc	1933	52	48	.....	.....	960	36	11/48	.....	.....	.....	
26acd2	.....	.....	.....	.....	.....	961	46	8/67	.....	.....	.....	
26bcb	.....	.....	.....	.....	.....	950	34 38	11/48 8/67	.....	.....	.....	
26bcc	1946	80	8	.....	.....	952	33 32R	11/48 6/57	330	.....	6/57	C, S.
27aca	.....	.....	14	.....	.....	952	41	8/67	.....	.....	.....	
34aac	.....	.....	.....	.....	.....	985	58 Dry	11/48 8/67	.....	.....	.....	
35abb1	1924	37	48	.....	.....	960	31 33 30	1/45 10/48 3/56	.....	.....	.....	
35abb3	1965	96	6	96	76- 96	960	45	8/67	.....	.....	.....	S.

Table 2.--Drillers' logs of selected wells in the Ranegras Plain

	Thick-ness (feet)	Depth (feet)		Thick-ness (feet)	Depth (feet)
(B-2-14)10cdc					
Clay	95	95	Sand and clay	75	455
Clay—gravel	245	340			
Coarse gravel and sand	40	380	TOTAL DEPTH		455
(B-4-15)7cbb					
Soil	4	4	Clay, cemented sand and gravel	113	528
Caliche	3	7			
Gravel	3	10	TOTAL DEPTH		528
Sand and clay	180	190			
Clay	225	415			
(B-4-15)18bbb					
Gravel	170	170	Gravel and rock	107	982
Clay and gravel	30	200	No sample	7	989
Clay	590	790	Rock and gravel	16	1,005
Shale and clay	40	830			
Rock and gravel	15	845	TOTAL DEPTH		1,005
Gravel and shale	30	875			
(B-4-15)18bcc					
Sand, clay, and boulders	83	83	Hard shale	36	879
Clay, caliche, and shells	149	232	Cemented gravel, sand and shells	18	897
Clay, streaks of sand	63	295	Conglomerated sand and pea-rock gravel	54	951
Sand, gravel, streaks of clay	40	335	Sand and gravel	200	1,151
Clay, streaks of sand	230	565	Black swamp mud	10	1,161
Clay, streaks of cemented gravel	66	631	Conglomerate	19	1,180
Clay with sand and gravel streaks	68	699	Gravel and sand, lime shells	20	1,200
Clay	23	722	Conglomerate and bentonite chalk	42	1,242
Black sticky shale	6	728			
Red shale and gravel	70	798	TOTAL DEPTH		1,242
Sand, streaks red shale	45	843			
(B-5-15)5daa					
Cement, gravel, some clay streaks	265	265	TOTAL DEPTH		343
Coarse gravel	65	330			
Cement gravel	13	343			
(B-5-15)6baa					
Surface sand and gravel	120	120	Gray sand, with occasional thin		
Clay with streaks of sand	280	400	streaks of clay	250	880
Sand	60	460	Hard dark gray sand	30	910
Clay	50	510			
Gray sand	90	600	TOTAL DEPTH		910
Sandy clay	30	630			
(B-5-15)18dda					
Surface sand	60	60	Clay,sand	195	540
Sandy clay	60	120	Clay	20	560
Clay,boulders	60	180	Sand	60	620
Sand	40	220	Bedrock—red clay with streaks sand	65	685
Sand	20	240	Volcanic formation	315	1,000
Dark running sand	40	280			
Gray sand	65	345	TOTAL DEPTH		1,000

Table 2. --Drillers' logs of selected wells in the Ranegras Plain—Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
(B-5-15)29daa					
Top soil	1	1	White and yellow clay	2	525
Caliche	124	125	Yellow clay	28	553
Yellow clay with sand and gravel	15	140	Sharp cemented sand and gravel—small	11	564
Yellow clay—sandy	127	267	White clay and sand	8	572
Yellow clay	38	305	Sharp gravel—tight	73	645
Conglomerate	35	340	Yellow clay—sand embedded hard	1	646
Yellow clay	55	395	Sharp tight gravel and clay	14	660
Rock and yellow clay	18	413	Yellow clay—hard sandy	110	770
Decomposed rock	41	454	Sharp gravel, streaks dirty sandstone	39	809
Rock formation	29	483	Sandstone with streaks yellow clay—hard	15	824
Yellow clay—sandy	29	512			
White clay, hard	11	523	TOTAL DEPTH		824
(B-5-15)29ddd					
Alluvial sand and clay, gray	68	68	Pink clay with 10 percent sand	46	656
Alluvial sand and clay, gray, with slight amount fine gravel	23	91	Gray sharp sand with mica flakes	67	723
Alluvial sand and clay, gray, with slight amount medium gravel, tan color	68	159	Gray sand, more rounded grains, no clay	91	814
Clay with some gravel	22	181	Gray gravel and clay, 30 percent clay, gravel rounded	48	862
Clay with gravel 1/4 inch in size, tan color	91	272	Gray sharp gravel	43	905
Clay with gravel 1/4 inch in size, gray color	22	294	Gray sharp gravel; correlates with 1,151 feet in Fewel No. 1	22	927
Clay, 70 percent; fine gravel, 30 percent; gray color	23	317	Gray sharp gravel with 10 percent clay	45	972
Medium to fine sand, grains sharp, pink	22	339	Gray gravel, slightly rounded, and clay, 50 percent of each	23	995
Medium to fine sand, grains sharp, gray in color	23	362	Gravel, slightly rounded, and clay, 50 percent of each, pink in color	23	1,018
Gravel and clay, 1/8 inch to 1/4 inch gravel, 30 percent clay, pink	68	430	Gravel, slightly rounded, 60 percent clay	45	1,063
No sample	45	475	Fine gray sand and clay, 30 percent clay	22	1,085
Gray sand and gravel, slight clay, gravel mixture of sharp rounded grains	23	498	Pink sandy clay, 90 percent clay	46	1,131
Sharp gray sand, some gravel	67	565	Gray clay with sand and gravel	23	1,154
Pink clay and sharp sand, 50 percent each	45	610	TOTAL DEPTH		1,154
(B-5-15)32ddd					
Alluvial clay	26	26	Clay with gravel and shale, gray	23	791
Sandy clay	42	68	Gravelly gray clay, 60 percent clay, 40 percent gravel	45	836
Clay	23	91	Gravel and gray clay, 1/8 inch round gravels, 10 percent clay	45	881
Clay and fine gravel	23	114	Fine gravel and sand, very little clay; mixture of rounded and sharp grains	46	927
Pink clay	67	181	Fine gravel and sand, very little clay; mixture of rounded and sharp grains, grains predominantly sharper	22	949
Pink clay with small amount fine sand	316	497	Pink clay, slight amount sand	68	1,017
Red clay carrying small amount sand	45	542	Pink clay, slight amount sand, slight amount small rounded gravel	42	1,059
Gray clay with fine rounded gravel. First reasonably good water-bearing formation	23	565	Gravel, gray	6	1,065
Fairly well rounded gravels with approximately 10 percent clay, gray	22	587	Medium fine sharp gray sand with small amount rounded grains	157	1,222
Fairly well rounded gravels with approximately 20 percent clay, gray	23	610	TOTAL DEPTH		1,222
Fairly well rounded gravels with approximately 20 percent clay, pink	45	655			
Gray clay with 30 percent gravel	23	678			
Nearly pure gray clay	22	700			
Red shale and gravel, fairly well rounded	23	723			
Gravel, gray, reasonably sharp grains	45	768			
(B-5-16)1aaa					
Surface sand	50	50	Sandy clay	75	795
Sandy clay	250	300	Variegated sand and gravel	105	900
Sand and small gravel	65	365	Malpais	40	940
Gravel	55	420			
Sandy clay	160	580	TOTAL DEPTH		940
Variegated sand and gravel	140	720			

Table 2.--Drillers' logs of selected wells in the Ranegras Plain—Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
(B-5-16)25dcc					
Silt	5	5	Soft sand, gravel, streaks clay	225	1,400
Caliche, gravel	115	120	Clay, streaks gravel	52	1,452
Fine sand	8	128			
Streaks volcanic ash, gravel	452	580	TOTAL DEPTH		1,452
Clay, streaks sand, gravel	200	780			
Chert with streaks cemented sand	395	1,175			
(B-6-16)22ada					
Sand, silt, and caliche	50	50	Sand	23	743
Silt and clay	60	110	Sand and gravel	22	765
Sand and gravel with streaks of clay	316	426	Sand and gravel, streaks of hard red shale	46	811
Sand and gravel	124	550	Sand and gravel, thin streaks of clay	43	854
Sand and clay	25	575	Clay with streaks of sand	24	878
Sand	55	630			
Clay, some with sand streaks	50	680			
Sand	30	710	TOTAL DEPTH		878
Clay	10	720			
(B-6-16)26aad					
Sand and caliche	67	67	Clay streaks with sand	73	785
Clay and silt	60	127	Sand	94	879
Streaks of clay with sand and gravel	229	356	Hard red shale	121	1,000
Sand and gravel	131	487	Red clay and sand streaks	269	1,269
Sand and clay	146	633			
Sand	79	712	TOTAL DEPTH		1,269
(B-6-16)33aaa					
Clay	158	158	Sand, gravel and boulders	180	700
Sandy clay	14	172			
Sand and gravel	348	520	TOTAL DEPTH		700
(B-7-17)23ca					
Sand, clay, and gravel	178	178	Grayish traprock with streaks of clay	240	690
Cemented gravel with streaks of clay	152	330			
Clay and shale	20	350	TOTAL DEPTH		690
Reddish conglomerate	100	450			

Table 3.--Field determinations of temperature and specific conductance of water from selected wells in the Ranegras Plain

Well location	Date measured (month, year)	Temperature (° C)	Specific conductance (micromhos at 25° C)
(B-4-16)9bda	8/67	35	825
(B-5-15)6baa1	3/54	29	---
	7/57	30	---
6bcb	7/57	30	---
18daa	10/51	33	---
	7/57	31	---
18dda	3/54	30	---
	7/57	31	---
29daa	6/67	34	1,500
32ddd	7/57	32	---
(B-5-16)25dcc	7/52	32	---
(B-6-16)12aaa	5/67	30	1,650
17baa	3/54	29	---
	7/57	29	---
	5/67	28	1,600
23ddc	6/67	30	1,500
33aaa	5/67	28	1,400
(B-7-17)26bcc	8/67	27	1,500
35abb3	8/67	27	1,300

Table 4.--Chemical analyses of ground water from selected wells in the Ranegras Plain

[Analytical results in milligrams per liter except as indicated]

Well location	Date of collection	Depth (feet)	Temperature (°C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids		Hardness as $CaCO_3$		Sodium-adsorption ratio (SAR)	Specific conductance (micromhos at 25°C)	pH (units)
															Milligrams per liter	Tons per acre-foot	Calcium, magnesium	Noncarbonate			
(B-4-14)30cca	11/48	250	....	15	10	1.9	271		106	0	136	250	8.9	21	776	1.04	33	0	21	1,370	....
(B-4-15)2daa	11/48	300	....	50	26	13	281		136	4.9	198	265	5.5	19	929	1.26	118	0	11	1,560	....
8aac1	11/48	420	....	15	203	1.3	333		26	0	900	175	6.5	16	1,660	2.26	512	490	6.4	2,290	....
18bbb	3/49	1,005	....	44	181	6.3	191		121	0	553	138	4.1	16	1,190	1.62	478	378	3.8	1,680	....
28bbd	11/48	....	....	35	25	5.0	262		77	0	166	265	5.1	38	839	1.14	83	20	12	1,440	7.3
(B-4-16)15abc	11/48	303	....	16	12	1.4	150		55	0	123	108	8.9	16	462	.63	36	0	11	774	8.0
(B-5-15)21baa	2/46	250	....	....	.....	.....	.....		164	0	....	208	.....	....	.....	....	.....	.....	.....	1,400	....
(B-5-16)9bcc	2/46	145	....	....	45	8.6	216		87	0	224	206	4.7	11	758	1.03	148	76	7.7	1,390	....
	11/48	....	....	....	.....	.....	.....		88	0	....	222	.....	....	.....	....	.....	.....	.....	1,420	....
(B-6-16)26aad	3/49	1,269	28	40	50	9.2	304		192	0	284	240	5.4	22	1,050	1.43	163	6	10	1,730	....
	9/60	....	....	35	97	22	364		128	0	430	380	4.9	28	1,420	1.93	332	227	8.7	2,270	7.0
(B-7-17)6bad	2/46	134	....	....	52	6.8	164		164	5.9	189	118	.....	9.4	626	.85	158	14	5.7	1,020	....
15cac	11/48	48	....	51	88	9.9	70		459	0	13	6.0	5.6	.5	470	.64	260	0	1.9	724	....
22aad1	2/46	44	....	....	344	68	888		126	0	886	1,430	4.4	20	3,700	5.03	1,140	1,040	11	5,630	....
23cac	11/49	92	25	34	52	17	181		193	0	287	86	4.2	5.6	762	1.04	200	42	5.6	1,460	....
26bcc	8/58	80	27	31	59	3.8	246		91	0	338	179	5.0	7.3	914	1.24	162	88	8.4	1,440	7.2
	9/63	....	27	....	.....	.....	.....		97	0	380	200	4.8	....	.....	....	186	106	.....	1,540	6.9

ARIZONA STATE LAND DEPARTMENT WATER-RESOURCES REPORTS
(Continued from inside front cover)

No.

17. Effects of ground-water withdrawal, 1954-63, in the lower Harquahala Plains, Maricopa County, Arizona, by R. S. Stulik: 8 p., 5 figs., 1964.

18. Basic ground-water data for western Pinal County, Arizona, by W. F. Hardt, R. E. Cattany, and L. R. Kister: 59 p., 4 figs., 1964.

19. Annual report on ground water in Arizona, spring 1963 to spring 1964, by N. D. White, R. S. Stulik, E. K. Morse, and others: 60 p., 27 figs., 1964.

20. Hydrologic and drill-hole data, San Xavier Indian Reservation and vicinity, Pima County, Arizona, by L. A. Heindl and N. D. White: 48 p., 3 figs., 1965.

21. Basic hydrologic data for San Simon basin, Cochise and Graham Counties, Arizona, and Hidalgo County, New Mexico, by N. D. White and C. R. Smith: 42 p., 4 figs., 1965.

22. Bibliography of U.S. Geological Survey water-resources reports, Arizona, 1891 to 1965, compiled by the Arizona District, Water Resources Division, U. S. Geological Survey: 59 p., 1965.

*23. Geohydrology of the Dateland-Hyder area, Maricopa and Yuma Counties, Arizona, by W. G. Weist, Jr.: 46 p., 8 figs., 1965.

*24. Annual report on ground water in Arizona, spring 1964 to spring 1965, by N. D. White and others: 62 p., 22 figs., 1965.

25. An appraisal of the ground-water resources of Avra and Altar Valleys, Pima County, Arizona, by N. D. White, W. G. Matlock, and H. C. Schwalen: 66 p., 12 figs., 1966.

26. Basic hydrologic data of the Hualapai, Sacramento, and Big Sandy Valleys, Mohave County, Arizona, by J. B. Gillespie, C. B. Bentley, and William Kam: 39 p., 6 figs., 1966.

27. Basic ground-water data for western Salt River Valley, Maricopa County, Arizona, by William Kam, H. H. Schumann, L. R. Kister, and F. E. Arteaga: 72 p., 11 figs., 1966.

28. Anticipated changes in the flow regimen caused by the addition of water to the East Verde River, Arizona, by H. W. Hjalmarson and E. S. Davidson: 10 p., 3 figs., 1966.

No.

29. Infiltration and recharge from the flow of April 1965 in the Salt River near Phoenix, Arizona, by P. C. Briggs and L. L. Werho: 12 p., 7 figs., 1966.

30. Hydrologic conditions in the Douglas basin, Cochise County, Arizona, by N. D. White and Dallas Childers: 26 p., 9 figs., 1967.

31. Compilation of flood data for Maricopa County, Arizona, through September 1965, by L. L. Werho: 36 p., 1 fig., 1967.

*32. Annual report on ground water in Arizona, spring 1965 to spring 1966, by E. B. Hodges and others: 61 p., 22 figs., 1967.

33. Basic ground-water data for southern Coconino County, Arizona, by E. H. McGavock: 49 p., 4 figs., 1968.

34. Spring flow into the Colorado River—Lees Ferry to Lake Mead, Arizona, by P. W. Johnson and R. B. Sanderson: 26 p., 5 figs., 1968.

35. Ground water in Paradise Valley, Maricopa County, Arizona, by F. E. Arteaga, N. D. White, M. E. Cooley, and A. F. Sutheimer: 76 p., 15 figs., 1968.

36. Annual report on ground water in Arizona, spring 1966 to spring 1967, by C. J. Cox and others: 43 p., 30 figs., 1968.

37. Ground-water conditions in the Waterman Wash area, Maricopa and Pinal Counties, Arizona, by E. E. Denis: 23 p., 9 figs., 1968.

38. Annual report on ground water in Arizona, spring 1967 to spring 1968, prepared under the direction of H. M. Babcock, District Chief, Arizona District, Water Resources Division, U.S. Geological Survey: 54 p., 32 figs., 1969.

39. Hydrologic conditions in the Gila Bend basin, Maricopa County, Arizona, by R. S. Stulik and Otto Moosburner: 63 p., 10 figs., 1969.

40. Ground-water conditions in McMullen Valley, Maricopa, Yuma, and Yavapai Counties, Arizona, by P. C. Briggs: 31 p., 9 figs., 1969.

41. Ground-water conditions in the Ranegras Plain, Yuma County, Arizona, by P. C. Briggs: 28 p., 7 figs., 1969.